

32 17. A method of manufacturing a biosensor for detecting an analyte of interest, comprising the steps of covering at least a portion of a surface with a film of a nanocrystalline semiconductor, contacting said preformed film with a protein such as to immobilise said protein on said film, such that the biosensor will be operative to detect the analyte.

Remarks

This paper is being submitted in follow up to a telephonic interview conducted with the Examiner on November 27, 2002. Again, the undersigned would like to express his appreciation for the courtesies extended by the Examiner.

During the interview a provisional agreement was reached that the rejection of the claims would be overcome by amending claims 1 and 17 to read as above set forth. The changes function to emphasize the differences between the claimed subject matter and teachings of the prior art.

The agreement was premised on the provision of an English language translation of WO 96/00198 and the same being no more pertinent than the related U.S. Patent No. 5,885,657, which already had been considered by the Examiner. Enclosed herewith is the requested English language translation.

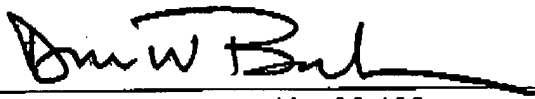
Finally, request is again made for issuance of a filing receipt. No filing receipt has been received by the undersigned.

This application is believed to be in condition for allowance and an early action to that effect is earnestly solicited.

Respectfully submitted,

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APPENDIX

In the Claims:

Please amend claims 1 and 17 to read as follows:

1. A biosensor for detecting an analyte of interest, comprising a surface, a nanocrystalline metal oxide semiconductor film at least partially covering said surface and at least one protein immobilized on at least a portion of said film, such that the biosensor will detect the analyte.

17. A method of manufacturing a biosensor for detecting an analyte of interest, comprising the steps of covering at least a portion of a surface with a film of a nanocrystalline semiconductor, contacting said preformed film with a protein such as to immobilise said protein on said film, such that the biosensor will be operative to detect the analyte.

Description

Production of ceramic layers and their use.

The process according to the invention describes the production of thin ceramic layers consisting of pure titanium dioxide or of titanium dioxide combined with other metal oxides at a temperature of 100°C within 5 minutes on glass, ceramic and metal.

The production of thin ceramic layers from titanium dioxide is known. The known processes, like the process according to the invention, start with a hydrolyzable titanium compound, hydrolyze same and first dissolve the precipitate resulting from the hydrolysis using acid, as a result of which a sol is obtained. Up to this point, the process according to the invention is identical to the state of the art.

According to the state of the art, the sol is now transformed into a gel. This is achieved, e.g. by concentrating the sol. When the gel is dried up further, it crystallizes out and forms cracks. For this reason, a surfactant is added to the gel to obtain a crack-free layer. At a temperature of approximately 400°C, which must naturally be maintained over an extended period of time, the titanium dioxide particles fuse together and the surfactant evaporates or decomposes. A nanocrystalline titanium dioxide layer remains.

This energy-intensive and time-consuming procedure can be very disadvantageous for practical applications, especially since the achieved strengths of the titanium dioxide layers are not very high.

The object of the present invention was the possibility of producing ceramic titanium dioxide layers which

- already at a very low temperature
- after only brief thermal treatment
- result in a better strength of the titanium dioxide layer.

For a practical application, with the process according to the invention, the production of solar cells as is described in PCT WO 91/16719, PCT WO 93/20569 and others, should initially be improved. The processes described in the reference literature have in common that surfactants must be used for the production of collector electrodes from titanium dioxide. The disadvantageous production conditions already described are therefore necessary to achieve a usable strength of the titanium dioxide layer to be produced.

The stated object of the process according to the invention described above is achieved in that a new course is followed with the sol produced by the hydrolysis of the titanium compound. The sol together with nanocrystalline titanium dioxide is blended to a dispersion. This dispersion is applied in a thin layer to the substrate to be treated. The hydrochloric acid and the water contained therein evaporate upon heating to 100°C. The stable dissolved equilibrium of the titanium dioxide present in the sol in colloidal form, originating from the hydrolysis, is consequently displaced. At the same time, van der Waals binding forces are building up at the grain boundaries of the added nanocrystalline titanium dioxide particles, which lead to an exceptionally strong titanium dioxide layer after only a few minutes.

The ceramic or ceramic-metallic layers which can be produced by this method at low temperatures, in addition to many conventional applications, can also be used for a range of novel applications of ceramics. Possible uses are as catalytically active layers, as sensors, for the immobilization of enzymes and catalysts, for the production of photovoltaic cells, for the production of photocatalytic layers, and also as filter-active layers for use as filter membranes. As a result of the good adhesion to metals, possible applications include temperature-resistant insulators for electrical wiring, but also capacitors with desired properties.

The advantage vis-à-vis the known production processes for ceramic layers consists according to the invention in that the object of the production of ceramic layers is already achieved under moderate thermal conditions. Along with the savings in production costs for purely ceramic layers, completely new possibilities arise, as thermally sensitive compounds, such as e.g. organic compounds, with defined catalytic, optical or electric properties, can be securely included in the ceramic bond.

Claims

The production of ceramic layers and their use

Claim 1

A process for the production of ceramic layers, characterised in that a dispersion which is produced by

- a) hydrolysing a hydrolysable titanium compound, e.g. 10 - 40 parts by weight, preferably 29 parts of titanium tetraisopropylate with 5 - 20 parts by weight, preferably 14 parts, water, and

b) subsequently peptizing the hydrolysate yielded by adding and stirring with a strong acid, preferably 42 parts by weight hydrochloric acid (25%) and
c) adding 10 - 25 parts by weight, preferably 15 parts, nanocrystalline and/or crystalline titanium dioxide to the solution so yielded, and mixing by stirring,
is applied as a thin layer of e.g. 0.1 to 10 μm to a glass, metal, ceramic or plastic carrier, e.g. by applying by doctor, by spraying, or by stamping, and is solidified on the carrier at a temperature of approximately 100°C, preferably in a hot air current, for approximately 5 minutes.

Claim 2

A process according to Claim 1, characterised in that instead of nanocrystalline and/or crystalline titanium dioxide, or in addition to titanium dioxide, another crystalline or nanocrystalline metal oxide, or a plurality of other crystalline or nanocrystalline metal oxides such as aluminium oxide, lead oxide, chromium oxide, iron oxide, indium oxide, copper oxide, magnesium oxide, ruthenium oxide, silicon oxide, titanium suboxide, vanadium oxide, tungsten oxide, zinc oxide, stannic oxide, zirconium oxide, or mixed oxides, such as silicates, titanates or selenides, tellurides, sulphides, carbides, nitrides in crystalline or nanocrystalline form are used for the production of the dispersion.

Claim 3

A process for the production of ceramic layers according to Claim 1 or Claim 2, characterised in that for the production of the dispersion, instead of, or in addition to, the metal oxide metal powder is used from aluminium, lead, bronze, chromium, iron, gold, Hastelloy, Inconel, copper, magnesium, molybdenum, monel, nickel, palladium, platinum, rhodium, rhenium, silver, stainless steel, tantalum, titanium, vanadium, tungsten, zinc, tin, or zirconium in powder form, preferably nanometre-sized particles.

Claim 4

Production of ceramic layers according to the preceding claims, characterised in that the substrate which is used as the support for the ceramic layer consists of porous glass nonwoven or sintered glass, porous ceramic or ceramic nonwoven, metal nonwoven or a porous sintered metal or plastic nonwoven or porous sintered plastic having a preferred pore width of from 0.5 to 30 μm .

Claim 5

Production of ceramic layers according to the previous claims for the water-and temperature-resistant, flat gluing of glass, ceramic and metal components, characterized by thin brushing over of the surfaces to be glued, wherein at least one of the surfaces to be glued must consist of porous material, with a dispersion prepared from 24 parts titanium tetraisopropylate, 12 parts water, 35 parts hydrochloric acid (25%) and 5 parts nanocrystalline titanium dioxide and 20 – 55 parts aluminium oxide (ALCOA 3000 CT) and/or 0 – 5 parts nanocrystalline aluminium oxide and then solidifying at 100°C within approximately 20 minutes.

Claim 6

Production of ceramic layers according to the previous claims for use for electric applications or in semiconductors, e.g. in photovoltaics for the production of collector electrode of titanium dioxide, characterized in that an electrode made of conductively coated glass or plastic, or a metal electrode is coated by doctor with a dispersion, prepared from e.g. 29 parts titanium tetraisopropylate, 14 parts water, 42 parts hydrochloric acid (25%) and 15-25 parts nanocrystalline titanium dioxide and, depending on the operation, instead of titanium dioxide, with photosensitized titanium dioxide and/or 0 - 5 parts nanocrystalline aluminium oxide, 0 - 2 parts titanium(III) chloride, in 1 - 5 operations, each at a thickness of 5 - 40 μm , and, after each application, is dried in a hot air current at 100°C for approximately 5 minutes.

Claim 7

Production of ceramic layers according to the previous claims for use in electrodes and as semi-conductor, e.g. as insulators and as capacitors, characterized in that the surface of conductive materials of e.g. aluminium is coated with e.g. a dispersion prepared from 29 parts titanium tetraisopropylate, 14 parts water, 42 parts hydrochloric acid (25%) and 15 parts nanocrystalline titanium dioxide, at a thickness of 5 - 10 μm , and is dried in a hot air current at 100°C for approximately 5 minutes, and as a result the conducting material layers are electrically insulated against each other when wound up.

Claim 8

Production of ceramic layers according to the previous claims for use in applications in biotechnology by the immobilization of enzymes in the ceramic layer, characterized in that 1 – 2 parts enzyme of the ceramic dispersion, e.g. formed from 29 parts titanium tetraisopropylate, 14 parts water, 42 parts hydrochloric acid (25%) and 15 parts nanocrystalline titanium dioxide, is added and stirred, and applied by doctor to a carrier at a thickness of 5 – 10 μm and dried for 1 hour in a hot air current at approximately 80°C.